

SECTION I: INTRODUCTION

Surface Transportation Research and Development Plan

Fourth Edition

I.a. The Role of Transportation in Society

The high level of mobility and access made possible by the US transportation system is critical to the economic well-being and quality of life of all Americans. The average person in the US travels approximately 17,000 miles annually, and 12,600 ton-miles of freight is moved each year per person. The ability to live far from the workplace, stores, and entertainment, to drive hundreds of miles on a weekend, or to fly across the country or to another continent on vacation or business, traveling whenever one wishes at an affordable cost, is a key component of most Americans' definition of a high level of quality of life. Indeed, on average, about 18 percent of household expenditures are for transportation.

More generally, transportation is an essential element in the functioning of the US economy. The sheer physical size of the US makes a high-quality, high performance and efficient national transportation system central to our economic efficiency and global competitiveness. Approximately 8 percent of the US workforce is employed in transportation-related functions, and total expenditures on transportation represent 11 percent of the gross domestic product.

The Nation's transportation system is vast in scope, including 3.9 million miles of roads, 1.4 million miles of oil and natural gas pipelines, 123,000 railroad route miles, and 26,000 miles of navigable waterways. There are more than 5,000 public-use airports, over 500 public transit operators, and 145 major ports. This infrastructure carries more than 4 trillion passenger-miles of travel and 3 trillion ton-miles of freight each year. There are nearly 200 million automobiles and light trucks—1.8 personal motor vehicles per household—that provide 87 percent of the total passenger-miles traveled. Most of the remainder is associated with 5,500 commercial airliners, nearly 740,000 buses of all kinds, 11,000 rail transit cars, and 2,000 intercity passenger railcars. The freight fleet encompasses 1.7 million combination trucks and nearly 6000 freight cars, as well as 31,000 barges, 5,000 towboats, and about 40,000 inland waterway vessels.

The physical presence and operation of this large and varied transportation system carries with it significant adverse societal impacts which pose a continuing challenge to the entire transportation community. While the US transportation system remains the safest in the world, and has shown steady improvement in this regard during the last several decades, it still accounts for almost half of all accidental deaths—more than 43,000 per year currently, about 95 percent of which arise in motor vehicle mishaps. The societal cost of transportation deaths, injuries and property damage has been estimated at \$150 billion per year.

Transportation activities are a significant source of environmental pollutants and other adverse effects. Highway vehicles alone produce a substantial fraction of four of the six pollutants for which the Environmental Protection Agency has set ambient air quality standards, and transportation as a whole is responsible for about one-third of US emissions of carbon dioxide, the primary greenhouse gas associated with potential global climatic change. Other societal impacts of transportation include noise, water and groundwater contamination, oil spills, oil storage leaks, solid wastes, and scrappage of vehicles and components (e.g., batteries and tires).

I.b. National Vision, Strategic Goals and Measures for Transportation

More than ever before, technological leadership is vital to our national interests. As stated in the recent National Science and Technology Council (NSTC) report, *Technology in the National Interest*, “Our ability to harness the power and promise of leading-edge advances in technology will determine, in large measure, our national prosperity, security, and global influence, and with them the standard of living and quality of life of our people.”

Technology is particularly essential to the health of our transportation system. America’s transportation system comprises a growing network of highways, transit systems, railroads, waterways, airports, airways, seaports, and pipelines that is critical to the nation’s vitality and economic well-being. Innovations in transportation contribute to America’s global competitiveness and national security. They enhance our environment and local communities. And, perhaps most importantly, they save lives and reduce the risk of accidents and injuries.

The NSTC Coordinating Committee on Transportation R&D (CTRD) recently completed the *Transportation Science and Technology Strategy* as a rationale and framework for guiding Federal long-term, strategic research and technology development that will make our transportation system safer, more productive, and more efficient. The Strategy supports the vision of the Committee, set forth in the Strategic Planning Document published in 1995, and the Administration’s National transportation goals:

“The Committee’s vision is of a sustainable and seamless intermodal transportation system that effectively ties America together and links it to the world. This system will help citizens and businesses satisfy their needs by providing efficient, safe, secure, and environmentally friendly transportation of people and goods. It will result from a strengthened partnership among government, academia, and the private sector focused on effective management and renewal of existing infrastructure, strategic deployment of new technologies and infrastructure, and on R&D which supports each of these.”

Based on its consideration of likely trends through the year 2020, the NSTC CTRD has defined five strategic goals for transportation to ensure progress toward this vision, and identified potential measures of overall progress toward those goals. These are summarized

below in Table I-1, and discussed at greater length in Section II of this report, which also addresses the evolutionary nature of the development of such measures.

<u>Strategic Goal</u>	<u>Outcome Measure</u>
Provide a safer transportation system.	Level of reduction in transportation-related fatalities, injuries, and property losses.
Achieve a high level of transportation system security.	Level of public trust and confidence in the security of the Nation's transportation network as determined through national surveys. ¹
Improve environmental quality and energy efficiency.	Number of major areas not now attaining legislatively-mandated air quality standards that reach these air quality goals by 2020. ²
Foster economic growth and productivity through global passenger and freight services.	Level of cost-effective passenger and freight throughput. ³
Ensure improved access <i>to</i> and increased mobility <i>on</i> the Nation's transportation system.	Degree of increased and enhanced access and mobility of the elderly, the poor, and other transportation-disadvantaged populations.

Table I-1. National Strategic Goals and Measures for Transportation

I.c. Conceptual Approach to Transportation Research and Development

Comprehensive and well-founded planning is essential for 21st century transportation challenges and opportunities to be met. A carefully structured framework and process are

¹Additional measures under consideration include: number of security incidents and threats by type of facility; level of transportation-related crime affecting goods movement and/or business and personal travel.

²Additional environmental indicators applicable to transportation are also under development. Examples include: states reporting highway-related wetlands losses; states reporting road salting as a significant source of groundwater contamination; and percent of population exposed to transportation-related noise associated with health and other effects.

³Additional measures under consideration in this area (see Section II, Chapter 6) include city-specific total hours of delay and/or speed distributions on different highway categories. Economic measures under consideration include volume-specific national passenger and freight transportation expenditures.

particularly necessary so that limited Federal research, development, and education and training resources can be managed and leveraged to achieve a strong and balanced overall program.

The NSTC CTRD is a central part of this planning process. Created in 1994, the Committee's role is to ensure that the Federal investment in transportation R&D is (1) coordinated to ensure efficient use of Federal funds aimed at this mission; (2) focused on projects identified by users, industry, and other stakeholders as being the most critical to achieving success in agencies' missions; and (3) limited to areas where it is clear that major public benefits can only be achieved through cost-shared Federal research.

Through its initial planning efforts (with major involvement of the transportation community) the Committee has completed the first *Transportation Science and Technology Strategy* to help Congress, the White House, and Federal agency heads to establish National transportation R&D priorities and coordinated research activities in support of National goals for the transportation system. The Strategy is based on the results of numerous outreach events, environmental scans, and an analysis of the transportation system's current and future strengths, weaknesses, opportunities, and threats.

The Strategy has a four-tiered approach to the shaping and implementation of surface transportation research, ultimately involving stakeholders at every stage in the process:

- ***Strategic Planning and Assessment*** to establish a research framework that embodies ***National Goals*** and establishes associated measures of transportation system performance by which research projects can be selected and evaluated.
- ***Strategic Partnership Initiatives***-- leveraged, multi-agency, and public-private in nature--that focus on the aggressive exploitation of rapidly evolving technological opportunities and the introduction of innovative equipment and operations into the transportation enterprise.
- ***Enabling Research*** in areas that support long-term transportation goals and contribute to long-term innovation and offer significant impacts affecting many modes of transportation, but have benefits too diffuse, uncertain, or far in the future to motivate sufficient private sector investment.



Figure I-1. Strategic Planning Approach

- ***Transportation Education and Training*** to assure the continued availability—in a time of rapid technical, demographic and other changes—of the highly-qualified transportation professionals and workers upon whom depends the design, construction, operation and maintenance of the Nation’s transportation system, ultimately determining its safety and performance.

I.d. Relationship between NSTC Strategy and this Plan, and Vision for the Future

This *Surface Transportation Research and Development Plan* addresses each of the above tiers in detail, and also presents the long-term view of the Department’s strategy for surface transportation R&D. Program-level plans addressing funding and staffing levels, and progress milestones will be developed through a strategic R&D planning process conducted in each of the Department’s operating administrations. This process will be coordinated within DOT through its Research and Technology Coordinating Council. Although this process has already involved a wide range of ongoing interagency coordination activities, the transition toward the more exhaustive and intensive collaboration is yet to come. It is anticipated that the Department’s program-level R&D plans will be structured based on the broad directions established in the NSTC *Transportation Science and Technology Strategy* beginning in FY 1999.

The central finding of the Council on Competitiveness, in its April 1996 report *Endless Frontier, Limited Resources: U.S. R&D Policy for Competitiveness*, is that “R&D partnerships hold the key to meeting the challenges of transition that our Nation faces.” This appear to be particularly true in the transportation enterprise. Because of the range of stakeholders in transportation, the successful creation of such partnerships among the private, public, and academic sectors will require more extensive, and earlier, involvement of these groups in the strategic planning of transportation research.

The *Transportation Science and Technology Strategy* completed recently by the NSTC represents a significant step in that direction. It establishes a research agenda for the Federal government which will form the basis for program-specific R&D plans developed by individual agencies, including those within DOT, for FY 1999 and beyond. There was substantial input from industry and academia, as well as from a few levels of government. However, it is now important to carry the process of coordinating the broad directions to the program level in a coherent, coordinated strategic planning framework.

Existing program-level plans, as evidenced by the third section of this *Surface Transportation Research and Development Plan*, were established according to goals not fully accepted by this Strategy. Nonetheless, ongoing coordination processes will be effective in refocusing the

relationships with the agenda of the Strategy. These relationships are illustrated in the first chapter of Section III.

The Department's vision is that the Administration's interagency Strategy will become the cornerstone of an expanded and integrated strategic planning process in which industry, government, and academia all participate actively. Ultimately, the Strategy, and plans for its implementation and assessment, would be documented through four key components:

- **A National *Transportation Science and Technology Strategy***—A strategy for transportation-related research throughout industry, government, and academia, developed through cooperative participation of all of these stakeholders.
- **A National *Transportation Research and Development Plan***--A program-level plan for implementation of the Strategy, identifying specific private/public/academic partnerships and enabling research activities, developed as above.
- **A DOT *Transportation Research and Development Plan***--A program-level plan for R&D to be conducted by all (including nonsurface) DOT operating administrations, identifying specific activities in support of partnerships and enabling research needs, developed on a coordinated but agency-specific basis.
- **An Assessment of the Impact of R&D Investments at All Levels**--An ongoing assessment of the degree to which transportation R&D programs are leading to the achievement of National goals for the transportation system.

Completion of the NSTC *Transportation Science and Technology Strategy* represents an initial step toward an expanded and integrated strategic planning process. This *Surface Transportation Research and Development Plan* is focused on surface transportation, and is, on a program-specific level, structured in terms of FY 1998 budget plans that preceded this Strategy. The Department expects to move subsequent editions of this report toward this broader vision by expanding the report to cover all transportation modes, and structuring program-specific budget plans in terms of the Strategy and its successors.

I.e. Authority

This is the fourth in a series of congressionally required plans submitted by the Secretary of Transportation to the Congress pursuant to Section 6009(b) of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The third edition of the plan was submitted in September 1996.

I.f. Plan Objectives and Congressional Mandate

ISTEA requires that an integrated National surface transportation research and development (R&D) plan be developed that focuses on surface transportation systems needed for the next decade. The congressionally mandated objectives of the plan are: 1) to develop a range of technologies needed to produce convenient, safe, and affordable modes of surface transportation to be available for public use beginning in the mid-1990's; and 2) to maintain a long-term advanced research and development program in order to provide for the next generation of surface transportation systems. In addition, ISTEA requires that the plan include the following:

"(A) Details of the Department's surface transportation research and development programs, including appropriate funding levels and a schedule with milestones, preliminary cost estimates, appropriate work scopes, personnel requirements, and estimated costs and goals for the next three years for each area of research and development.

(B) A ten-year projection of long-term programs in surface transportation research and development and recommendations of the Research and Development Coordinating Council of the Department of Transportation and the plan of the National Council on Surface Transportation Research.

(C) Recommendations on changes needed to assure that Federal, State, and local contracting procedures encourage the adoption of advanced technologies developed as a consequence of the research programs in this Act [ISTEA]."

I.g. Scope

Surface transportation R&D, broadly defined, is conducted by a number of Federal organizations (e.g., DoD, DOT, EPA, DOE), by State and local government agencies, by academic institutions, and by the private sector. Within that context, this plan focuses on the surface transportation research underway or planned within the six DOT administrations with direct responsibility for surface transportation:

- Federal Highway Administration (FHWA)
- National Highway Traffic Safety Administration (NHTSA)
- Federal Railroad Administration (FRA)
- Maritime Administration (MARAD)
- Federal Transit Administration (FTA)
- Research and Special Programs Administration (RSPA).

Other departmental research, including that conducted by the Federal Aviation Administration's (FAA), the U.S. Coast Guard (USCG), and the Office of the Secretary of

Transportation (OST) is addressed when it correlates specifically to research being conducted on surface transportation issues. In particular, FAA's Aviation Human Factors Program, discussed briefly in Section III, is specifically related to the human factors programs being conducted in FRA, NHTSA, FHWA, FTA, MARAD, and USCG. Other FAA research and technology programs are also related. The Aviation Security program remains a top priority, and the Airport Pavements program continues efforts to improve airport pavement in order to accommodate the next generation of very large aircraft. These efforts are detailed in FAA's 1997 Plan for Research, Engineering, and Development published in January 1997. The *Surface Transportation Research and Development Plan* also discusses activities of the Bureau of Transportation Statistics (BTS), as these have a very direct role in supporting the Department's strategic planning and system assessment efforts. As mentioned above, it is hoped that this report can be expanded in the future to encompass all of the Department's transportation research, not just the surface elements.

The near-term section of this plan focuses on research underway or planned in FY 1997, 1998, and 1999. In response to the directive in ISTEA, the plan provides details of the surface transportation R&D programs, including funding levels, milestones, and personnel requirements. The plan's long-term outlook outlines a conceptual approach to transportation R&D that includes ongoing strategic planning; priority partnership R&D initiatives, ten of which address surface transportation; a set of six broad-based enabling long-term research areas critical to long-term progress in transportation; education and training to maintain a skilled transportation workforce in the future; and the measurement of progress toward strategic goals and of performance of specific programs. The plan's final chapter on contracting provides an overview of current contracting practices, summaries of recent changes in legislation and regulations, and brief descriptions of relevant contracting studies and task force efforts that are currently in progress or have been completed since the last edition of this plan.

This edition of the R&D plan, like the previous edition, emphasizes a strategic vision for surface transportation R&D activities. As in the three previous editions, the Department has relied extensively on its ongoing outreach activities in establishing R&D priorities. For this edition of the plan, comments specific to the plan have been obtained through a number of processes discussed in Section II. The Department has supplemented its ongoing outreach efforts through an intensive solicitation of outside input specifically related to this report, including first-ever publication on the Internet.

I.h. Plan Organization

This plan is divided into the following sections related to surface transportation R&D:

- *Section II* presents a strategic vision and direction for surface transportation, establishes a context for that vision by examining a number of key future trends and issues, and presents a range of specific initiatives and long-term enabling research areas relevant to

surface transportation. The plan emphasizes long-term integration and coordination of departmental R&D efforts in implementing these core endeavors, as well as partnering to leverage scarce R&D resources in the private, public, and academic sectors. This section also discusses the development of performance measures as a necessary underpinning of ongoing strategic planning for effective resource utilization.

- *Section III* outlines the Department's near-term (FY 1997-1999) surface transportation research program in five major areas: (1) physical infrastructure; (2) information infrastructure; (3) next-generation vehicles and fuels; (4) human-centered transportation systems, and (5) intermodal systems assessment, design, planning, management, and operations. This Section also discusses related university and cooperative research activities, and gives an overview of administrative and facility planning associated with these programs. Relationships between the Department's near-term R&D programs and the partnership initiatives and enabling research areas identified in Section II are explored in the first chapter of Section III.
- *Section IV* discusses contracting procedures affecting the Department and its grantees.

I.i. Changes From the Last Edition

As noted above, this edition, like the last, presents a long-term vision for surface transportation and a strategic plan for long-term R&D activities in one section, and an overview of near-term activities in a following section. This fourth edition of the report, drawing heavily upon the recently completed NSTC Transportation Committee *Transportation Science and Technology Strategy*, establishes a tiered structure for transportation R&D, consisting of the four components discussed above. This structure, presented in the second section of the report, moves away from a strict distinction between near- and long-term R&D, and toward a more focused set of long-term research areas, and a set of strategic initiatives which could be pursued immediately, and are more pointedly oriented toward private/public partnering.

The third section, as in the previous edition, describes the Department's near-term R&D programs, and consists of eight chapters that rely heavily on the framework established by the Transportation Committee of the National Science and Technology Council (NSTC). Although most of the content of this section is similar in structure, scope, and detail to that of the last edition, the third chapter, which addresses information infrastructure R&D, has been expanded to reflect the finer details of the ITS program, as well as the distribution of responsibility within DOT operating administrations.